

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	"6709532".pn. or "6613156".pn.	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/03/22 15:34
L2	2	("5953587" "6355125").PN. OR ("6709532").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/03/22 15:34
L3	9	("3604435" "6001191" "6199564" "6244279" "6342104" "6347637" "6383303" "6430841" "6435199").PN. OR ("6613156"). URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/03/22 15:35
L4	11	I2 or I3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/03/22 15:37
L5	1	I4 and butyl acetate	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/03/22 15:37

WEST Search History

DATE: Thursday, March 22, 2007

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<i>DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=YES; OP=ADJ</i>			
<input type="checkbox"/>	L55	L52 and polyimide	24
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<input type="checkbox"/>	L50	(air knife) or blow	369923
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L53: Entry 26 of 26

File: USPT

Jul 26, 1988

DOCUMENT-IDENTIFIER: US 4759823 A

TITLE: Method for patterning PLZT thin films

Brief Summary Text (10):

The method, in one aspect, provides for the patterning of sintered PLZT family thin films. A photoresist layer is applied to a sintered PLZT family thin film which has been fabricated on a substrate. The photoresist layer is processed by conventional photolithographic processing to produce a photoresist mask. The photoresist mask thus formed functions to protect the PLZT family thin film underneath the patterned photoresist during the etching process. The sintered PLZT family coated substrate, with the patterned photoresist coating defining the desired circuit elements is preferably placed in an aqueous etching solution containing hydrochloric acid and fluorine ion donor of a concentration sufficient to etch that portion of the sintered PLZT layer not covered with the patterned photoresist layer in from 2 to 15 seconds. This etching removes substantially all of the exposed PLZT family film without significant undercutting. After the initial etching step is completed, the sintered PLZT family coated substrate is removed from the initial etching bath, rinsed, and placed in a dilute lead solubilizing solution, such as nitric acid, for a sufficient period of time to remove the residue remaining after the initial etching step. Thereafter, the substrate is removed from the second etching solution and rinsed with deionized water, and next, the remaining photoresist is removed from the sintered PLZT family thin film by use of a conventional photoresist stripper, resulting in the final patterned sintered PLZT family film.

Brief Summary Text (15):

All percentages and ratios herein are based on volume unless otherwise specified. The substrate is left in the initial etching bath for a period of time sufficient to dissolve substantially all of the sintered PLZT family layer not protected by the photoresist, without significant undercutting of the sintered PLZT family layer protected by the photoresist. Etching should be accomplished in 2 to 15 seconds. The substrate is next removed from the initial etching bath and then rinsed with deionized water. Following the rinse, the substrate is placed in a second etching bath containing a lead solubilizing solution, preferably a dilute nitric acid solution. Thereafter, the substrate is removed from the second etching bath, rinsed, and the photoresist layer is removed with a suitable photoresist stripper. The substrate with the desired sintered PLZT family film pattern thereon can then be processed for semiconductor use.

Brief Summary Text (17):

Semiconductor integrated circuits are typically fabricated using planar processes. Such processing involves the definition of dopants into selected regions of a silicon substrate followed by the formation, through deposition or other processes, of various layers which are then etched to form patterned elements. The deposited layers include conductive metals, insulators and passivating materials. Each layer is patterned by use of a separate mask which is used in conjunction with standard photolithographic techniques involving photoresist mask materials and strippers. In the formation of an integrated circuit using the PLZT family material, this material is deposited as one of the layers in the manufacturing process. However,

successful patterning requires the process described herein rather than those conventionally used with other insulating and conducting layers which form a part of the integrated circuit.

Detailed Description Text (21):

The photoresist mask is stripped from the top of the remaining unsintered PLZT family film and the film is sintered. Thereafter the sintered PLZT family film is covered with a photoresist mask of the desired pattern.

Detailed Description Text (29):

After the second etching process is completed, the substrate having the PLZT thin film with overlying photoresist pattern is removed from the second etching bath and rinsed with deionized water. The film is then dried in a suitable manner, such as blow drying with an inert gas, such as nitrogen, which is the preferred method, or spun dry by spinning it at high speed. After drying, the overlying photoresist pattern is removed using known immersion methods in standard chemicals such as the R-10 method. R-10 is the trade designation for a 5.1N solution of diethylene glycol monobutyl ether sold by KTI Chemicals Inc. The removal of the photoresist pattern then reveals the replicated PLZT thin film pattern remaining on the substrate.

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L53: Entry 25 of 26

File: USPT

Nov 28, 2000

DOCUMENT-IDENTIFIER: US 6153075 A

** See image for Certificate of Correction **

TITLE: Methods using electrophoretically deposited patternable material

Detailed Description Text (18):

As previously indicated, it will be readily apparent to one skilled in the art that the electrophoretic deposition process will be different dependent upon the patternable material being used and the system used to perform such deposition. Various components may be used with the tank housing to perform the electrophoretic deposition process. For example, such components are described in the articles referenced herein and include, but clearly are not limited to, filtration components, heaters, additional baths or other methods to rinse excess resist from the coated substrate prior to coalescence, particle filters to remove contamination of the emulsion bath, overflow networks, agitators, vibratory equipment, and dryers. For example, the removal of excess water from the coated substrate assembly may include the use of a dry hot nitrogen tank, an air knife technique, a nitrogen gas spray assembly, a spin dry technique or by evaporation techniques, as are known to those skilled in the art.

Detailed Description Text (51):

Thereafter, the photoresist 310 is removed, such as by an oxygen plasma strip, thermal strip, or wet organic stripper, and the structure precleaned for electrophoretically depositing and forming another patterned layer 320 of photoresist over the formed blue phosphor element 312 and the conductive surface 305, as shown in FIG. 6B in a manner as described previously with reference to FIGS. 1 and 2. Further, the patterned photoresist 320 defines an opening for the deposition or formation of a green phosphor light emitting element 314 therein. The structure resulting after the formation of the green phosphor light emitting element 314 is shown in FIG. 6B.

Detailed Description Text (52):

Thereafter, after stripping the photoresist 320 and precleaning the surfaces, another patterned layer 330 of photoresist is electrophoretically deposited over the blue phosphor light emitting element 312, green phosphor light emitting element 314 and the conductive surface 305, and then patterned to define an opening for the formation of a red phosphor light emitting element 334, as shown in FIG. 6C. After formation of the red phosphor light emitting element 334, using any process or technique for performing such deposition or formation, the photoresist 330 is stripped resulting in the three-color pattern display structure shown in FIG. 6D. Further, it should be readily apparent that the order of application of the color light emitting elements to the face plate may vary, e.g., blue then green then red, red then green then blue, etc.

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L55: Entry 24 of 24

File: USPT

Oct 6, 1998

DOCUMENT-IDENTIFIER: US 5817441 A

** See image for Certificate of Correction **

TITLE: Process for preparation of color filter and liquid crystal display device

Detailed Description Text (29):

(c) When the photosensitive resin composition is of a negative-type, portions, which have been screened by a mask 3 upon the exposure, are dissolved out in a developing solution by development to bare the surface of the substrate, and the exposed portions are left as a black matrix pattern 2. Subsequently, the thus-developed coating film is rinsed to wash out the developing solution, and simply dried by means of spin drying, air knife or the like. Thus, the substrate surface 4 of the space areas between the black matrices turns to be clean.

Detailed Description Text (36):

Examples of the nonphotosensitive resin used include polyimide, acrylic monomers and urethane acrylates.

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L45: Entry 60 of 110

File: PGPB

May 16, 2002

DOCUMENT-IDENTIFIER: US 20020058103 A1

TITLE: VACUUM DEPOSITED NON POLYMERIC FLEXIBLE ORGANIC LIGHT EMITTING DEVICES

Abstract Paragraph:

An organic light emitting device (OLED) is disclosed for which the hole transporting layer, the electron transporting layer and/or the emissive layer, if separately present, is comprised of a non-polymeric material. A method for preparing such OLED's using vacuum deposition techniques is further disclosed.

Summary of Invention Paragraph:

[0002] The subject invention is directed to flexible organic light emitting devices (OLED's) including a hole transporting layer and/or an electron transporting layer comprised of a vacuum-deposited, non-polymeric material.

Summary of Invention Paragraph:

[0003] In one type of electrically controlled light emitting device, organic material is placed between a layer of conductive material that can inject electrons and a layer of conductive material that can inject holes. When a voltage of proper polarity is applied between the outer layers of conductive material, electrons from one layer combine with holes from the other so as to release energy as light that is, to produce electroluminescence (EL). These devices are referred to as organic light emitting devices, OLED's.

Summary of Invention Paragraph:

[0004] OLED's have been constructed from polymers so as to have a highly advantageous flexibility that enables them to be used for light weight, portable, roll-up displays or to be used for conformable displays which can be readily attached to windows, windshields or instrument panels that may have curved surfaces; "The Plastic LED: A Flexible Light-Emitting Device Using a Polyaniline Transparent Electrode" by G. Gustafsson et al in "Synthetic Metals", 55-57 4123-4227 (1993). Even though there is a widespread application of vacuum-deposited, small-molecule-based heterostructural OLED's, which have been constructed on inflexible glass substrates and use ITO as the hole emitting layer, the devices of Gustafsson were fabricated using a polymer, that is, soluble semiconducting polymer poly(2-methoxy, 5-(2'-ethyl-hexoxy)-1,4-phenylene-- vinylene) (MEH-PPV) as the emissive layer, since the mechanical properties of polymers were deemed to be unique with respect to making such devices.

Summary of Invention Paragraph:

[0005] It would be desirable if flexible OLED's could be fabricated having improved electroluminescent properties as well as the advantage of being readily fabricated using the vacuum deposition techniques typically used for preparing OLED's.

Summary of Invention Paragraph:

[0006] In accordance with this invention, a flexible OLED using small molecule based heterostructure of organic material is provided in which the hole transporting layer, the electron transporting layer, and/or the emissive layer, if separately present, includes a non-polymeric material, that is, a layer comprised of small molecules.

Summary of Invention Paragraph:

[0007] The term "small molecules" is used herein to refer to molecules which are small in the sense that such molecules are not made up of a plurality of repeating molecular units such as are present in a polymeric material. Thus, for purposes of this invention, the term "small molecule" is intended to be used interchangeably with the term "non-polymeric." In fact, the term "small molecules" may embrace relatively large molecules such as are typically used in the hole transporting layer, the electron transporting layer and/or the emissive layer that is present in an OLED.

Summary of Invention Paragraph:

[0008] The subject invention is further directed to a method of fabricating flexible OLED's wherein the hole transporting layer, the electron transporting layer and/or the emissive layer, if present, may be prepared using vacuum deposition techniques, rather than using the less convenient fabrication technique such as employed by Gustafsson et al, that is, rather than spin coating a layer of polymer, such as polyaniline onto the flexible substrate. Such vacuum deposition methods are particularly suitable for use in fabricating the OLED's of the subject invention since the other layers of the OLED are also typically prepared using vacuum deposition techniques. Integration of all the vacuum deposition steps into a single overall sequence of steps for fabricating the OLED, without requiring the use of solvents or removing the air sensitive layers from a vacuum chamber and exposing them to ambient conditions provides an additional especially beneficial advantage. Thus, the subject invention is directed to a method, wherein the hole transporting, electron transporting, and/or separate emissive layer, if present, may be prepared using vacuum deposition steps.

Brief Description of Drawings Paragraph:

[0009] FIG. 1 is a cross section of one embodiment of a flexible OLED constructed in accordance with this invention;

Brief Description of Drawings Paragraph:

[0010] FIG. 2 contains graphs illustrating the current vs. voltage characteristic of an OLED such as shown in FIG. 1 before and after repeated bending and the current vs. voltage characteristic of a prior art OLED having a glass substrate in place of the flexible polyester substrate; and

Brief Description of Drawings Paragraph:

[0011] FIG. 3 contains graphs illustrating the optical power vs. current characteristics of an OLED such as shown in FIG. 1 before and after repeated bending and the current vs. voltage characteristic of a prior art OLED used in a glass substrate in place of the flexible polyester substrate.

Brief Description of Drawings Paragraph:

[0013] FIG. 5 shows a photograph of an array of nine unpackaged 1 cM.sup.2 vacuum-deposited, non-polymeric flexible OLED's. One device in contact with the probe arm is shown operating in air in a well-illuminated room at normal video display brightness (-100 cd/m.sup.2)

Detail Description Paragraph:

[0015] As illustrative embodiments of the subject invention, the subject OLED's may be incorporated into a single heterostructure or in a double heterostructure. The materials, methods and apparatus for preparing the single and double heterostructures are disclosed, for example, in U.S. Pat. No. 5,554,220, which is herein incorporated in its entirety by reference. The subject invention as disclosed herein may be used in conjunction with co-pending applications, "High Reliability, High Efficiency, Integratable Organic Light Emitting Devices and Methods of Producing Same;" "Novel Materials for Multicolor LED's;" "Electron Transporting and Light Emitting Layers Based on Organic Free Radicals;" "Multicolor Display Devices;" "Red-Emitting Organic Light Emitting Devices (LED's);" and "High

Efficiency Organic Light Emitting Device Structures;" each of said co-pending application being filed on Dec. 23, 1996, and being herein incorporated in their entirety by reference. The subject invention may also be used in conjunction with co-pending U.S. Ser. Nos. 08/354,674; 08/613,207; 08/632,316; 08/632,322; and 08/693,359; which are also herein incorporated in their entirety by reference.

Detail Description Paragraph:

[0016] The single or double heterostructures, as referred to herein, are intended solely as examples showing how-an OLED embodying the subject invention may be fabricated without in any way intending the invention to be limited to the particular sequence or order of making the layers shown. For example, a single heterostructural OLED of the subject invention includes a flexible substrate, which is preferably transparent; a first electrode, which may typically be an indium tin oxide (ITO) anode layer; a hole transporting layer; an electron transporting layer; a second electrode layer, for example, a metal cathode layer of Mg:Ag; and a metal protective layer, for example, made of a layer of Ag, for protecting the Mg:Ag cathode layer from atmospheric oxidation. A double heterostructure would also include an additional layer containing an emissive material. This additional layer is herein referred to as a "separate emissive layer" so as to distinguish it from the other layers, since the hole transporting layer and the electron transporting layer can be made to produce electroluminescent emission without the need for this separate emissive layer.

Detail Description Paragraph:

[0018] The ability to achieve highly flexible displays vacuum-deposited molecular organic materials, which have stable electroluminescent properties, depends on, *inter alia*, the following two factors. First, the molecular bonds responsible for the mechanical properties of the thin films comprising the OLED needs to be reasonably tolerant of the stress applied to the structure on bending, and, second, the substrates needs to be sufficiently flat and uniform such that mechanical defects are not formed during growth or flexing.

Detail Description Paragraph:

[0019] Concerning the first factor, virtually all organic materials used in vacuum-deposited OLED's are held together by highly flexible van der Waals bonds. Previously, it has been shown, Y. Zhang and S. R. Forrest, *Phys. Rev. Lett.* 71, 2765 (1993), that the bonding of aromatic molecules similar to those used in OLED's is highly compressible. For example, it was shown that the compressibility of the van der Waals-bonded naphthalene-based molecular crystal NTCDA has a roughly 20-times-higher compressibility than most ductile metals such as In or Al. C. Kittel, *Solid State Physics*, 4th ed. (Wiley, New York, 1971) p. 143. While not intending to be limited to the theory of why the subject invention is capable of producing stable electroluminescence, such considerations help to explain why the molecular materials disclosed herein are sufficiently ductile to undergo significant stress without cracking.

Detail Description Paragraph:

[0020] The second factor, that the substrates used be sufficiently flat, was established through the use of images produced by an atomic force microscope. These images, such as shown in FIG. 4, shows that the ITO surface had a rms roughness of only 1.8 nm, whereas the polyester surface of the flexible was somewhat rougher, with a rms value of 2.8 nm. Although there was some variation from substrate to substrate, ITO surface roughness did not exceed 3.6 nm. In either case, the substrates were sufficiently smooth (*i.e.*, the height of the surface features was a small fraction of the total device thickness) such that no significant damage was observed for the subject OLED heterostructure on growth or bending.

Detail Description Paragraph:

[0021] Based on such considerations, the subject devices grown on flexible substrates were found to have efficiencies comparable with conventional vacuum-

deposited OLED's grown on glass and, furthermore, such devices were found to be mechanically robust.

Detail Description Paragraph:

[0025] In accordance with another aspect of the invention, the light emitting device of FIG. 1 may be fabricated as follows. In this example, the substrate 2 is a 175 μ .M thick (1 μ .M=10⁻⁶ meters) transparent polyester sheet precoated with a transparent, conducting ITO thin film 4. The thickness of the flexible substrate may be either substantially thicker or thinner depending on the needs of the particular application which the OLED is used. The sheet resistance of the ITO thin film 4 was 60 Ω ./.quadrature., and the transparency of the coated substrate was -80% throughout the visible spectrum. Prior to the deposition of the organic film, the substrate 2 was ultrasonically cleaned in detergent for two minutes, then rinsed with deionized water. Next, it was rinsed in 2-propanol, held at room temperature for two to three minutes, and then boiled in 2-propanol again for two to three minutes, followed by drying with a blow gun using a stream of filtered dry nitrogen. An 800 .ANG. thick layer 6 of the hole conducting material, TPD, was deposited by thermal evaporation in a vacuum of $<4 \times 10^{-7}$ Torr, followed by the deposition of a 800 .ANG. thick Alq₃ layer. The top electrode consisted of a 1500 .ANG. thick layer of Mg--Ag and a 500 .ANG. thick Ag cap deposited through a shadow mask. A conventional device on an ITO-precoated glass substrate was simultaneously fabricated for comparison using identical cleaning and deposition procedures. The sheet resistance and transparency of the ITO-precoated glass substrate was 20 Ω ./.quadrature. and -90%, respectively.

Detail Description Paragraph:

[0026] FIG. 2 shows the current-voltage characteristics of a 1 mm diameter flexible device prior to bending, curve 16, after repeated bending (4 to 5 times) over a small radius of curvature (-0.5 cm), curve 18, and the conventional device on a glass substrate, curve 20. All the current/voltage curves are shown to follow the power law dependence of current-on-voltage. At lower voltages, the current/voltage curves indicate ohmic behavior; while at higher voltages, the curves follow $I \propto V^{m+1}$ with $m=7$, suggestive of trap-limited conduction typical of OLED's. The power law dependence was observed for at least four orders of magnitude change in current in the high current region. There was no obvious change in the current/voltage characteristics after the device was repeatedly flexed. The turn-on voltages (defined as the voltages at which the current due to ohmic and trap limited conduction are equal) of the three curves was almost identical (-6.5V), while the leakage current at low voltages of the flexible device was even less than that of the conventional device, and was not increased after bending. This indicated that the ITO film precoated on the flexible substrate is sufficiently uniform such that current shunt paths between the top and bottom contacts 12 and 4 are not induced after bending, even for very thin film (-1600 .ANG. molecular organic structures).

Detail Description Paragraph:

[0028] Large-area (-1 cm²) devices were also fabricated by similar methods. As in the case of the smaller devices, the large devices were also be bent over radii of -0.5 cm without apparent degradation. That these larger areas can be achieved indicates that flexible OLED's can be used in large, roll-up, or conformable flat panel displays. This, in conjunction with the fact that the ITO-precoated substrate is available in large spools, indicates that flexible, OLED-based displays can be mass manufactured on a roll-to-roll basis by use of suitable volume growth technologies such as organic vapor phase deposition.

Detail Description Paragraph:

[0029] Failure modes of the large-area device were also studied. If on the convex side of a curved substrate the device can be bent without failure even after a permanent fold occurs in the polyester film. If on the concave side the device remains operational when bent over a radius of curvature down to 0.5 cm. At smaller

radii, cracks propagate through the device, and current-shunt paths are created between bottom and top contacts after further bending. When ITO-precoated substrates are similarly bent, the same cracking phenomenon is observed, from which it can be inferred that the cracks occur in the ITO rather than in the OLED itself.

Detail Description Paragraph:

[0030] In conclusion, vacuum-deposited, van der Waals-bonded, non-polymeric flexible OLED's, such as illustrated in FIG. 5, have been fabricated using an ITO-precoated transparent polyester film as the substrate. It has been shown that an ITO thin film, when precoated on a flexible substrate, provides a flat, highly transparent, conductive, flexible contact suitable for OLED applications. This hole-injecting ITO-coated substrate may also be used with OLED's comprising polymeric hole transporting, electron transporting, and/or emissive layers comprised of polymers. In addition, performance similar to that disclosed herein is expected if non-polymeric devices are vacuum deposited on polymeric, transparent hole-injecting contacts such as polyaniline, which may be useful if even greater flexibility is required in certain applications.

Detail Description Paragraph:

[0031] Although a particular OLED structure of FIG. 1 has been described, it is to be understood that any OLED structure having layers that are vacuum formed could be formed on a flexible polymeric substrate in accordance with this invention. Those of skill in the art may recognize certain modifications to the various embodiments of the invention, which modifications are meant to be covered by the spirit and scope of the appended claims.

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